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(54) Title: PYRIMIDINOXYALKYLPIPERAZINES AND THEIR THERAPEUTIC USE

(57) Abstract: Pyrimidinoxyalkylpiperazines of the formula (I) in which n represents an integer from 2 to 6, R<sub>1</sub> represents H, C<sub>1</sub>-C<sub>6</sub>-alkyl or phenyl (C<sub>1</sub>-C<sub>6</sub>)-alkyl in which the phenyl radical can be substituted by one or more substituents selected from C<sub>1</sub>-C<sub>6</sub>-alkyl and C<sub>1</sub>-C<sub>6</sub>-alkoxy, R<sub>2</sub> represents H, C<sub>1</sub>-C<sub>4</sub>-alkyl, OH, C<sub>1</sub>-C<sub>6</sub>-alkoxy, NH<sub>2</sub> or C<sub>1</sub>-C<sub>6</sub>-halogenoalkyl, R<sub>3</sub> and R<sub>4</sub>, independently of each other, represent H, C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>1</sub>-C<sub>6</sub>-hydroxyalkyl, C<sub>1</sub>-C<sub>6</sub>-halogenoalkyl, pyrrolyl or phenyl, which latter can be substituted by one or more substituents selected from C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>1</sub>-C<sub>6</sub>-hydroxyalkyl, C<sub>1</sub>-C<sub>6</sub>-alkoxy, OH, halogen or C<sub>1</sub>-C<sub>6</sub>-halogenoalkyl, phenyl, cyano or nitro. The compounds can be used for treating diseases which respond to modulation of the dopamine D<sub>3</sub> receptor and are characterized by a high degree of bioavailability.

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## Pyrimidinoxyalkylpiperazines and their therapeutic use

## Description

5 The present invention relates to pyrimidinoxyalkylpiperazines and their therapeutic use. The compounds possess valuable therapeutic properties and can be used, in particular for treating diseases which respond to modulation of the dopamine D<sub>3</sub> receptor.

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Neurones obtain their information by way of G protein-coupled receptors, inter alia. There are a large number of substances which exert their effect by way of these receptors. One of these substances is dopamine.

15

Firm insights exist with regard to the presence of dopamine and its physiological function as a neurotransmitter. Disturbances in the dopaminergic transmitter system result in diseases of the central nervous system which include, for example, schizophrenia, depression and Parkinson's disease. These and other diseases are treated with drugs which interact with the dopamine receptors.

20

25 Up until 1990, two subtypes of dopamine receptor had been clearly defined pharmacologically, namely the D<sub>1</sub> and D<sub>2</sub> receptors. More recently, a third subtype has been found, namely the D<sub>3</sub> receptor, which appears to be able to mediate some effects of the antipsychotic agents and anti-Parkinson agents (J.C. Schwartz et al., The Dopamine D<sub>3</sub> Receptor as a Target for Antipsychotics, in Novel Antipsychotic Drugs, H.Y. Meltzer, Ed. Raven Press, New York 1992, pages 135-144; M. Dooley et al., Drugs and Aging 1998, 12, 495-514).

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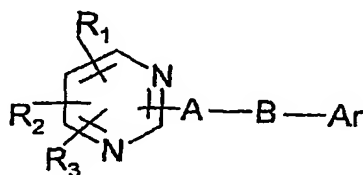
Since D<sub>3</sub> receptors are principally expressed in the limbic system, it is assumed that, while a selective D<sub>3</sub> ligand should probably have the properties of known antipsychotic agents, it should not have their dopamine

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D<sub>2</sub> receptor-mediated neurological secondary effects (P. Sokoloff et al., Localization and Function of the D<sub>3</sub> Dopamine Receptor, *Arzneim. Forsch./Drug Res.* 42(1), 224 (1992); P. Sokoloff et al., Molecular Cloning and  
5 Characterization of a Novel Dopamine Receptor (D<sub>3</sub>) as a Target for Neuroleptics, *Nature*, 347, 146 (1990)).

WO 96/02519 discloses substituted pyrimidine compounds of the Formula

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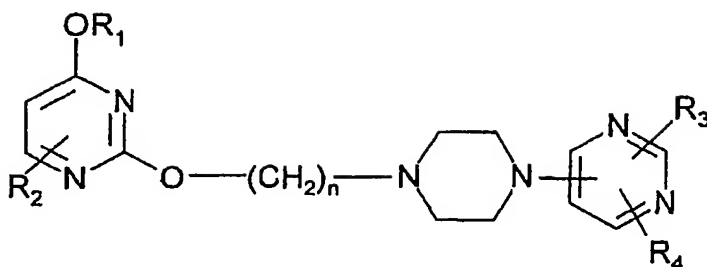
in which R<sub>1</sub>, R<sub>2</sub>, R<sub>3</sub>, A, B and Ar have defined meanings. The compounds of WO 96/02519 are selective dopamine D<sub>3</sub>  
15 receptor ligands and are effective, inter alia, for treating schizophrenia, depression and psychoses.

It is desirable to have available selective dopamine D<sub>3</sub> receptor ligands which exhibit a high degree of  
20 bioavailability, in particular a high degree of cerebral availability. Compounds which exhibit a high degree of bioavailability have the advantage that a given threshold concentration of the drug at the site of action can be achieved using a lower dose which is  
25 to be administered orally. Conversely, when a given dose is administered, a higher concentration of the drug is achieved at the site of action.

The invention is therefore based on the object of  
30 making available selective dopamine D<sub>3</sub> receptor ligands which exhibit a high degree of bioavailability.

This object is achieved by means of pyrimidinoxyalkyl-piperazines of the Formula I

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in which

n represents an integer from 2 to 6,

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R<sub>1</sub> represents H, C<sub>1</sub>-C<sub>6</sub>-alkyl or phenyl-(C<sub>1</sub>-C<sub>6</sub>)-alkyl in which the phenyl radical can be substituted by one or more substituents selected from C<sub>1</sub>-C<sub>6</sub>-alkyl and C<sub>1</sub>-C<sub>6</sub>-alkoxy,

10

R<sub>2</sub> represents H, C<sub>1</sub>-C<sub>4</sub>-alkyl, OH, C<sub>1</sub>-C<sub>6</sub>-alkoxy, NH<sub>2</sub> or C<sub>1</sub>-C<sub>6</sub>-halogenoalkyl,

15 R<sub>3</sub> and R<sub>4</sub>, independently of each other, represent H, C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>1</sub>-C<sub>6</sub>-hydroxyalkyl, C<sub>1</sub>-C<sub>6</sub>-halogenoalkyl, pyrrolyl or phenyl, which latter can be substituted by one or more substituents selected from C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>1</sub>-C<sub>6</sub>-hydroxyalkyl, C<sub>1</sub>-C<sub>6</sub>-alkoxy, OH, halogen or C<sub>1</sub>-C<sub>6</sub>-halogenoalkyl, phenyl, cyano or nitro,

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with the proviso that the radicals R<sub>3</sub> and R<sub>4</sub> on the pyrimidine ring are in each case arranged in the m position (metaposition) in relation to each other and to the piperazine substituent on the pyrimidine ring, and at least one of the radicals R<sub>3</sub> and R<sub>4</sub> represents C<sub>3</sub>-C<sub>6</sub>-alkyl or C<sub>3</sub>-C<sub>6</sub>-hydroxyalkyl, which in each case possesses a branched alkyl chain or is bonded to the pyrimidine ring by way of a secondary carbon atom, or trifluoromethyl,

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and their piperazine-N-oxides and salts with pharmaceutically tolerated acids.

Within the context of the present application:

Halogen denotes: fluorine, chlorine, bromine or iodine;

5

C<sub>1</sub>-C<sub>6</sub>-alkyl denotes: methyl, ethyl, propyl, 1-methylethyl, butyl, 1-methylpropyl, 2-methylpropyl, 1,1-dimethylethyl, pentyl, 1-methylbutyl, 2-methylbutyl, 3-methylbutyl, 2,2-dimethylpropyl, 1-ethylpropyl, hexyl, 1,1-dimethylpropyl, 1,2-dimethylpropyl, 1-methylpentyl, 2-methylpentyl, 3-methylpentyl, 4-methylpentyl, 1,1-dimethylbutyl, 1,2-dimethylbutyl, 1,3-dimethylbutyl, 2,2-dimethylbutyl, 2,3-dimethylbutyl, 3,3-dimethylbutyl, 1-ethylbutyl, 2-ethylbutyl, 1,1,2-trimethylpropyl, 1-ethyl-1-methylpropyl and 1-ethyl-3-methylpropyl;

10

15

C<sub>1</sub>-C<sub>6</sub>-alkoxy denotes; C<sub>1</sub>-C<sub>6</sub>-alkyloxy containing a C<sub>1</sub>-C<sub>6</sub>-alkyl radical as mentioned above;

20

C<sub>1</sub>-C<sub>6</sub>-halogenoalkyl denotes: a C<sub>1</sub>-C<sub>6</sub>-alkyl radical, as mentioned above, in which one or more hydrogen atoms is/are substituted by fluorine, chlorine, bromine and/or iodine;

25

C<sub>1</sub>-C<sub>6</sub>-hydroxyalkyl denotes: a C<sub>1</sub>-C<sub>6</sub>-alkyl radical, as mentioned above, in which one or more hydrogen atoms is/are replaced with hydroxyl groups;

30

C<sub>3</sub>-C<sub>6</sub>-alkyl or C<sub>3</sub>-C<sub>6</sub>-hydroxyalkyl, which is bonded by way of a secondary or tertiary carbon atom, denotes: a (hydroxy)alkyl radical having from 3 to 6 carbon atoms in which the carbon atom, by way of which the (hydroxy)alkyl radical is linked to the basic molecule, is linked to 2 or 3 further carbon atoms in the (hydroxy)alkyl radical; such as 1-methylethyl, 1-methylpropyl, 1,1-dimethylethyl, 1-methylbutyl, 1-ethylpropyl, 1,1-dimethylpropyl, 1-methylpentyl, 1,1-dimethylbutyl, 1-ethylbutyl, 1,1,2-trimethylpropyl, 1-

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ethyl-1-methylpropyl and 1-ethyl-3-methylpropyl; or the said radicals in which one or more hydrogen atoms is/are replaced with hydroxyl groups.

- 5 In the pyrimidinoxyalkylpiperazines of the Formula I, at least one of the radicals  $R_3$  and  $R_4$  preferably represents  $C_3$ - $C_6$ -alkyl which is bonded to the pyrimidine ring by way of a secondary or tertiary carbon atom, preferably 1-methylethyl or 1,1-dimethylethyl, or  $C_3$ - $C_6$ -  
10 hydroxyalkyl which is bonded to the pyrimidine ring by way of a secondary or tertiary carbon atom, preferably 2-hydroxy-1-methylethyl or 2-hydroxy-1,1-dimethylethyl.

In the pyrimidinoxyalkylpiperazines of the Formula I,  
15  $R_1$  preferably represents H or benzyl whose phenyl radical can be substituted by one or more, preferably 1, 2 or 3,  $C_1$ - $C_6$ -alkoxy radicals, for example 3,4-dimethyloxybenzyl, 4-methoxybenzyl, 2,3,4-trimethoxybenzyl, 3,4,5-trimethoxybenzyl or 2,5-dimethoxybenzyl.

20 In the pyrimidinoxyalkylpiperazines of the Formula I,  $R_1$  represents, in particular, H.

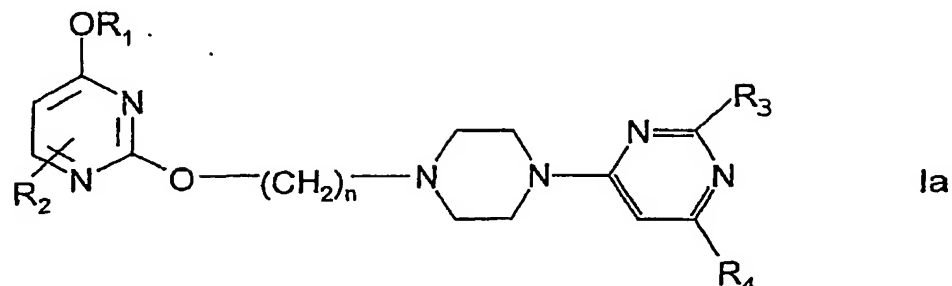
In the pyrimidinoxyalkylpiperazines of the Formula I,  
25  $R_2$  preferably represents H, methyl, ethyl, OH,  $C_1$ - $C_6$ -alkoxy, trifluoromethyl or difluoromethyl; and in particular represents H or OH.

In the pyrimidinoxyalkylpiperazines of the Formula I,  
30  $R_3$  and  $R_4$  preferably represent, independently of each other, H,  $C_1$ - $C_6$ -alkyl,  $C_1$ - $C_6$ -hydroxyalkyl,  $C_1$ - $C_6$ -halogenoalkyl or phenyl, which latter can be substituted by one or more substituents selected from  $C_1$ - $C_6$ -alkyl,  $C_1$ - $C_6$ -alkoxy, halogen or phenyl.

35 In the pyrimidinoxyalkylpiperazines of the Formula I, n preferably represents 3 or 4.

Preferred embodiments of the pyrimidinoxyalkyl-

piperazines according to the invention are those of the Formula Ia



5

in which  $R_1$ ,  $R_2$ ,  $R_3$ ,  $R_4$  and  $n$  have the abovementioned meanings and preferred meanings.

More strongly preferred embodiments of the  
 10 pyrimidinoxyalkylpiperazines of the Formula Ia are those in which  $R_3$  represents  $C_3$ - $C_6$ -alkyl which is bonded to the pyrimidine ring by way of a tertiary carbon atom, and

15  $R_4$  represents  $C_1$ - $C_6$ -alkyl,  $C_1$ - $C_6$ -halogenoalkyl or phenyl, which latter can be substituted by one or more substituents selected from  $C_1$ - $C_6$ -alkyl,  $C_1$ - $C_6$ -alkoxy, halogen or phenyl.

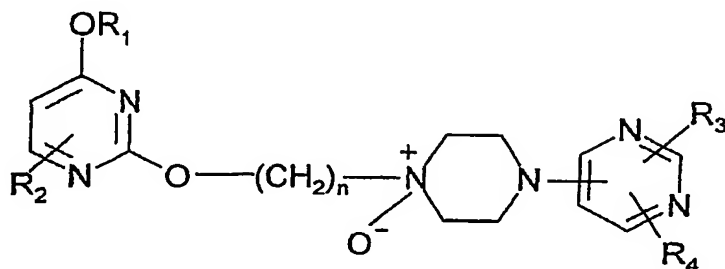
20 Other preferred embodiments of the pyrimidinoxyalkylpiperazines of the Formula Ia are those in which  $R_3$  represents trifluoromethyl and  $R_4$  represents  $C_1$ - $C_6$ -alkyl,  $C_1$ - $C_6$ -halogenoalkyl or phenyl.

25 The invention also encompasses the acid addition salts of the pyrimidinoxyalkylpiperazines of the Formula I with physiologically tolerated acids. Examples of suitable physiologically tolerated organic and inorganic acids are hydrochloric acid, hydrobromic  
 30 acid, phosphoric acid, sulphuric acid, oxalic acid, maleic acid, fumaric acid, lactic acid, tartaric acid, adipic acid and benzoic acid. Other acids which can be used are described in Fortschritte der Arzneimittel-

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forschung [Advances in Drug Research], Volume 10, p. 224 ff., Birkhäuser-Verlag, Basel and Stuttgart, 1966.

- 5 The invention also relates to the piperazine-N-oxides of compounds of the Formula I which can be depicted by the following formula



10

They are obtained by treating a compound of the Formula I with an oxidizing agent, in particular an inorganic or organic peroxide or hydroperoxide, such as hydrogen peroxide, or percarboxylic acids, such as peracetic acid, perbenzoic acid or m-chloroperbenzoic acid.

The pyrimidinoxyalkylpiperazines of the Formula I can be prepared in a variety of ways. They are preferably obtained using one of the following processes A or B.

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#### Process A

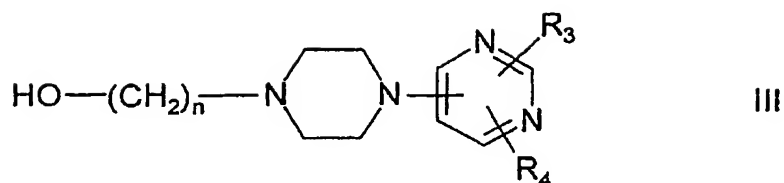
The compounds according to the invention can be obtained by reacting a compound of the Formula II

25



II

with a compound of the Formula III



in which  $Y_1$  represents a leaving group which can be displaced nucleophilically, such as halogen,  $C_1$ - $C_6$ -alkylthio,  $C_1$ - $C_6$ -alkylsulphonyl,  $C_1$ - $C_6$ -alkylsulphinyl or the like, and  $R_1$ ,  $R_2$ ,  $R_3$ ,  $R_4$  and  $n$  have the meaning which have already been indicated.

The reaction is preferably carried out in the presence of a diluent. All the solvents which are inert towards the reagents employed can be used for this purpose. Examples of these diluents are water and aliphatic, alicyclic and aromatic hydrocarbons which can in each case be chlorinated, where appropriate, such as hexane, cyclohexane, petroleum ether, ligroin, benzene, toluene, xylene, methylene chloride, chloroform, carbon tetrachloride, ethyl chloride and trichloroethylene, ethers, such as diisopropyl ether, dibutyl ether, methyl tert-butyl ether, dioxane and tetrahydrofuran, ketones, such as acetone, methyl ethyl ketone, methyl isopropyl ketone and methyl isobutyl ketone, nitriles, such as acetonitrile and propionitrile, alcohols, such as methanol, ethanol, isopropanol, butanol and ethylene glycol, esters, such as ethyl acetate and amyl acetate, acid amides, such as dimethylformamide, dimethylacetamide and N-methylpyrrolidone, sulphoxides and sulphones, such as dimethyl sulphoxide and sulpholane, bases, such as pyridine, and cyclic ureas, such as 1,3-dimethylimidazolidin-2-one and 1,3-dimethyl-3,4,5,6-tetrahydro-2(1H)-pyrimidone.

In this connection, the reaction is preferably carried out in a temperature range of between  $0^\circ\text{C}$  and the boiling point of the diluent. The reaction preferably takes place in the added presence of a suitable base.

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An alkali metal or alkaline earth metal hydride, such as sodium hydride, potassium hydride or calcium hydride, a carbonate, such as alkali metal carbonate, e.g. sodium carbonate or potassium carbonate, an alkali metal hydroxide or alkaline earth metal hydroxide, such as sodium hydroxide or potassium hydroxide, an organometallic compound, such as butyllithium, or an alkali metal amide, such as lithium diisopropylamide, can serve as the base.

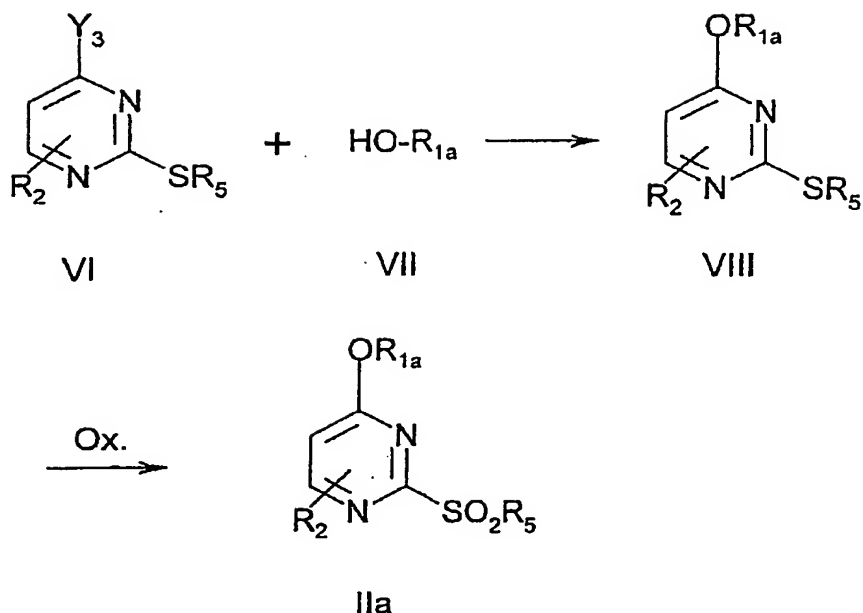
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The compounds of the Formula II are known or can be prepared in a customary manner.

Compounds of the Formula II, in which  $Y_1$  represents  $C_1$ - $C_6$ -alkylsulphonyl, can be obtained, for example, by means of a two-step reaction, with a mercaptopyrimidine of the Formula VI, in which  $Y_3$  represents halogen, in particular chlorine, bromine or iodine, and  $R_5$  represents  $C_1$ - $C_6$ -alkyl, initially being reacted with an alcohol of the Formula VII, in which  $R_{1a}$  has the meanings given for  $R_1$  with the exception of H, and the resulting intermediate of the Formula VIII being oxidized with an oxidizing agent for oxidizing the  $C_1$ - $C_6$ -alkylthio group to the  $C_1$ - $C_6$ -alkylsulphonyl group.

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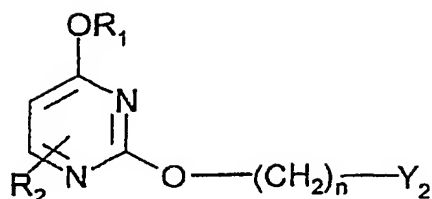
Examples of suitable oxidizing agents are halogens, such as chlorine or bromine, peroxides or peracids, such as hydrogen peroxide or perbenzoic acid, perhalogenates, such as sodium periodate, transition metal oxidizing agents, such as disodium tungstate or potassium permanganate, and the like.

In the compound of Formula IIa, the radical  $R_{1a}$  can, if desired, be converted into hydrogen using customary methods for removing the protecting group. However, this conversion is preferably effected after the compound of the Formula IIa has reacted with the compound of the Formula III.

The compounds of the Formula III can be prepared in accordance with customary methods, for example in a manner analogous to that described in WO 97/25324.

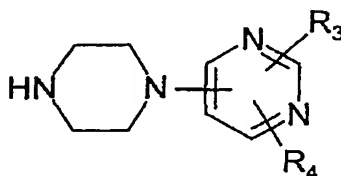
#### Process B

The compounds according to the invention can also be prepared by reacting a compound of the Formula IV



IV

with a compound of the Formula V



V

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in which  $Y_2$  represents a leaving group which can be displaced nucleophilically, for example halogen, in particular chlorine, bromine or iodine,  $C_1$ - $C_6$ -alkylsulphonyloxy or  $C_6$ - $C_{10}$ -arylsulphonyloxy, and  $R_1$ ,  $R_2$ ,  $R_3$ ,  $R_4$  and  $n$  have the meaning which have already been indicated.

The reaction preferably takes place in a diluent and in the presence of a base. Suitable diluents and bases are those mentioned above.

The compounds of the Formula V are known or can be prepared in a customary manner, for example in accordance with methods which are analogous to those described in WO 97/25324. The compounds of the Formula IV can be prepared in a customary manner, for example by reacting a compound of the Formula II with an  $\alpha,\omega$ - $C_2$ - $C_6$ -alkanediol, and converting the aliphatic OH group in the resulting intermediate into a leaving group which can be displaced nucleophilically.

The pyrimidinoxyalkylpiperazines according to the invention are selective dopamine  $D_3$  receptor ligands which act regioselectively in the limbic system and, because of their low affinity for the  $D_2$  receptor, have

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fewer secondary effects than do the classic neuroleptic agents, which are D<sub>2</sub> receptor antagonists. The compounds can therefore be used for treating diseases which respond to dopamine D<sub>3</sub> ligands, i.e. they are effective for treating those diseases in which modulation of the dopamine D<sub>3</sub> receptors leads to an improvement of the disease picture or to the disease being cured. Examples of diseases of this nature are diseases of the central nervous system, in particular schizophrenia, emotional disturbances, neurotic, stress and somatoform disturbances, psychoses, attention deficit disorders, amnesic and cognitive disturbances, such as impaired learning and memory (impaired cognitive function), depression and addiction diseases.

The addiction diseases include the psychic disturbances and behavioural disturbances caused by the abuse of psychotropic substances, such as pharmaceuticals or drugs, and also other addiction diseases, such as compulsive gambling (impulse control disorders not elsewhere classified). Examples of addiction-generating substances are: opioids (e.g. morphine, heroin and codeine); cocaine; nicotine; alcohol; substances which interact with the GABA-chloride channel complex, sedatives, hypnotics or tranquilizers, for example benzodiazepines; LSD; cannabinoids; psychomotor stimulants, such as 3,4-methylenedioxy-N-methylamphetamine (ecstasy); amphetamine and amphetamine-like substances, such as methyl phenidate, or other stimulants, including caffeine. Addition-generating substances which particularly come into consideration are opioids, cocaine, amphetamine or amphetamine-like substances, nicotine and alcohol.

The compounds according to the invention are preferably employed for treating emotional disturbances; neurotic, stress and somatoform disturbances and psychoses, schizophrenia, depression or addiction diseases.

For treating the abovementioned diseases, the compounds according to the invention are administered orally or parenterally (subcutaneously, intravenously, intramuscularly or intraperitoneally), in a customary manner. The compounds can also be administered through the nasopharynx using vapours or sprays. However, administration preferably takes place orally.

The dosage depends on the age, condition and weight of the patient and on the mode of administration. As a rule, the daily dose of active compound is from about 10 to 1 000 mg per patient and day when administered orally.

The invention also relates to pharmaceutical compositions which comprise the pyrimidinoxyalkyl-piperazines according to the invention and/or their salts. These compositions are present in the customary galenic administration forms in solid or liquid form, for example as tablets, film tablets, capsules, powders, granules, sugar-coated tablets, suppositories, solutions or sprays. In this connection, the active compounds can be processed together with the customary galenic auxiliary substances, such as tablet binders, fillers, preservatives, tablet disintegrants, flow regulators, plasticizers, wetting agents, dispersants, emulsifiers, solvents, retardants, antioxidants and/or propellant gases (cf. H. Sucker et al., Pharmazeutische Technologie [Pharmaceutical technology], Thieme-Verlag, Stuttgart, 1978). The resulting administration forms customarily comprise the active compound in a quantity of from 1 to 99% by weight.

The following examples serve to explain the invention without delimiting it.

#### Examples

##### Example 1

- 14 -

4-[4-(3-{[4-(Benzyloxy)-2-pyrimidinyl]oxy}propyl)-1-piperazinyl]-2,6-di-tert-butylpyrimidine

Preparing the starting compounds:

5

A 1) 4-(Benzyloxy)-2-(methylmercapto)pyrimidine

16.4 g (151 mmol) of benzyl alcohol were added dropwise, and under a protective gas, to a suspension  
10 of 6.8 g (227 mmol) of sodium hydride (80% strength) in 150 ml of dioxane, and the mixture was stirred at 100°C for 30 min. A solution of 24.3 g (151 mmol) of 4-chloro-2-(methylmercapto)pyrimidine in 100 ml of dioxane was added dropwise, at 50°C, to this  
15 suspension, and the mixture was subsequently stirred for a further two hours at 50°C. After the reaction had come to an end, the mixture was acidified with glacial acetic acid, treated with water and extracted several times with dichloromethane. The combined organic phases  
20 were dried over sodium sulphate, filtered and evaporated.

Yield: 12.5 g (87% of theory)

<sup>1</sup>H NMR (CDCl<sub>3</sub>): δ = 2.5 (s, 3H); 5.5 (s, 2H); 6.4 (d, 1H); 7.4-7.5 (m, 5H); 8.3 (d, 1H).  
25

A 2) 4-(Benzyloxy)-2-(methylsulphonyl)pyrimidine

34.7 g (150 mmol) of A 1) were treated, in a  
30 dichloromethane/water two-phase system (volume ratio 4/3) and at from -5° to 0°C, with chlorine gas until the solution was saturated. The mixture was subsequently flushed with nitrogen and heated to room temperature. For the working-up, the phases were  
35 separated, the aqueous phase was re-extracted with dichloromethane, and the combined organic phases were dried over sodium sulphate, filtered and evaporated. The residue was purified chromatographically (silica gel, dichloromethane containing 1% methanol).

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Yield: 17 g (46% of theory) of a colourless oil

$^1\text{H}$  NMR ( $\text{CDCl}_3$ ):  $\delta$  = 3.3 (s, 3H); 5.5 (s, 2H); 6.9 (d, 1H); 7.3-7.5 (m, 5H); 8.5 (d, 1H).

5

B 1) 2,6-di-tert-Butyl-4-pyrimidinol

The above pyrimidine was synthesized, in a manner known per se, by condensing 2,2-dimethylpropionamidine with ethyl trifluoroacetoacetate and sodium methoxide in ethanol, see Heterocyclic Compounds, Vol. 52, The Pyrimidines, p. 189 ff., D.J. Brown et al. (Eds.) John Wiley and Sons, 1994.

m.p. 169°C

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B 2) 2,6-di-tert-Butyl-4-chloropyrimidine

Phosphorus oxychloride or thionyl chloride was used, in a manner known per se, to convert the hydroxypyrimidine from step B 1) into the chloro compound, see Heterocyclic Compounds, Vol. 52, The Pyrimidines, p. 329 ff., John Wiley and Sons, 1994.

The compound is present as a yellowish oil.

25 B 3) 2,6-di-tert-Butyl-4-(1-piperaziny)pyrimidine

18 g (0.18 mol) of piperazine were dissolved in 25 ml of ethanol. While boiling at reflux, a solution of 7.2 g (0.03 mol) of the chloride obtained in accordance with B 2), dissolved in 10 ml of ethanol, was added dropwise to it within the space of 1 h. After 30 min, the mixture was left to cool. 200 ml of water was then added to the mixture and the whole was extracted with a total of 200 ml of methylene chloride in several portions. The combined organic phase was subsequently washed with water, dried with anhydrous sodium sulphate and concentrated. The desired compound was obtained as a yellowish oil, which was subjected to further processing as the crude compound.

- 16 -

Yield: 98% of theory

B 4) 3-[4-(2,6-di-tert-Butyl-4-pyrimidinyl)-1-piperazinyl]-1-propanol

5

3.7 g (36 mmol) of triethylamine, 8.33 g (30 mmol) of the compound described under B 3) and 30 mg of sodium iodide were added consecutively to a solution of 5.0 g (36 mmol) of 3-bromo-1-propanol in 40 ml of tetrahydrofuran and the mixture was heated while boiling for 14 h. For the working-up, the salts were filtered off, the mother liquor was concentrated in vacuo, the residue was taken up in dichloromethane and the organic phase was washed twice with water. The combined organic phases were dried over sodium sulphate and filtered, and the filtrate was evaporated. The residue was purified chromatographically (silica gel, dichloromethane/methanol = 97/3).

10

15

Yield: 5.4 g (83% of theory)

20

<sup>1</sup>H NMR (CDCl<sub>3</sub>): δ = 1.3 (s, 9H); 1.4 (s, 9H); 1.8 (q, 2H); 2.6 (m, 4H); 2.7 (t, 2H); 3.6 (t, 4H); 3.9 (t, 2H); 6.2 (s, 1H).

25 Preparing the title compound

2.3 g (6.8 mmol) of the compound prepared under B 4) were dissolved in 25 ml of dimethylformamide and deprotonated with 0.3 g (8.5 mmol) of sodium hydride; a solution of 1.8 g (6.8 mmol) of the compound prepared under A 2) above in 15 ml of DMF was then added and, after 16 h at room temperature, the mixture was hydrolysed with ice water and extracted with methyl tert-butyl ether. The combined organic phases were dried over sodium sulphate and filtered, and the filtrate was evaporated. The residue was purified chromatographically (silica gel, dichloromethane/methanol = 97/3).

30

35

Yield: 0.9 g (25% of theory)

- 17 -

<sup>1</sup>H NMR (CDCl<sub>3</sub>): δ = 1.3 (s, 9H); 1.4 (s, 9H); 2.1 (m, 2H); 2.5-2.6 (m, 6H); 3.6 (m, 4H); 4.5 (t, 2H); 5.5 (m, 2H); 6.3 (s, 1H); 6.4 (d, 1H); 7.3-7.5 (m, 5H); 8.2 (d, 1H).

## Example 2

2-{3-[4-(2,6-di-tert-Butyl-4-pyrimidinyl)-1-piperazin-yl]propoxy}-4-pyrimidinol

0.4 g (0.8 mmol) of the compound described in Example 1 was dissolved in 40 ml of ethyl acetate and hydrogenated with hydrogen in the presence of 10 mol% of palladium on charcoal and at atmospheric pressure. After the reaction had come to an end, the catalyst was filtered off and the filtrate was concentrated and the residue was purified chromatographically (silica gel, dichloromethane/methanol = 97/3).

Yield: 0.25 g (76% of theory).

<sup>1</sup>H NMR (CDCl<sub>3</sub>): δ = 1.3 (s, 9H); 1.4 (s, 9H); 2.0 (q, 2H); 2.5 (m, 6H); 3.6 (m, 4H); 4.5 (t, 2H); 6.1 (d, 1H); 6.3 (s, 1H); 7.8 (d, 1H).

C<sub>23</sub>H<sub>36</sub>N<sub>6</sub>O<sub>4</sub>S

(428.6)

m.p.: 149-151°C

The following examples of compounds of the general Formula I were obtained in an analogous manner.

- 18 -

## Example 3

4- (Benzyloxy) -2- (4- {4- [2-tert-butyl-6- (trifluoro-  
methyl)-4-pyrimidinyl] -1-piperazinyl}butoxy) -5-methyl-  
5 pyrimidine

m.p. 88-90°C (hydrochloride)

## Example 4

10

4- (Benzyloxy) -2- (3- {4- [2-tert-butyl-6- (trifluoro-  
methyl)-4-pyrimidinyl] -1-piperazinyl}propoxy) -5-methyl-  
pyrimidine

15 m.p. 116-120°C (hydrochloride)

## Example 5

2- (3- {4- [2-tert-Butyl-6- (trifluoromethyl) -4-  
20 pyrimidinyl] -1-piperazinyl}propoxy) -5-methyl-4-  
pyrimidinol

m.p. 94-96°C (hydrochloride)

25 Example 6

4- [4- (3- { [4- (Benzyloxy) -2-pyrimidinyl] oxy}propyl) -1-  
piperazinyl] -2-tert-butyl-6- (trifluoromethyl)pyrimidine

30 m.p. 87°C (hydrochloride)

## Example 7

2- (4- {4- [2-tert-Butyl-6- (trifluoromethyl) -4-pyrimidin-  
35 yl] -1-piperazinyl}butoxy) -5-methyl-4-pyrimidinol

<sup>1</sup>H NMR (CDCl<sub>3</sub>): δ = 1.4 (s, 9H); 1.6 (m, 2H); 1.8 (m,  
2H); 2.0 (s, 3H); 2.5 (t, 2H); 2.6 (m, 4H); 3.7 (m,  
4H); 4.4 (t, 2H); 6.6 (s, 1H); 7.6 (s, 1H); 10.4 (br,

- 19 -

OH).

$C_{22}H_{31}F_3N_6O_2$  (468.5)  $[M+H^+] = 469.3$

## 5 Example 8

2-(3-{4-[2-tert-Butyl-6-(trifluoromethyl)-4-pyrimidin-  
yl]-1-piperazinyl}propoxy)-4-pyrimidinol

10 m.p. 164-165°C

## Example 9

2-(3-{4-[2-tert-Butyl-6-(trifluoromethyl)-4-pyrimidin-  
15 yl]-1-piperazinyl}propoxy)-6-methyl-4-pyrimidinol

m.p. 155-156°C

## Example 10

20

2-tert-Butyl-4-(4-{3-[(4-methoxy-2-pyrimidinyl)oxy]-  
propyl}-1-piperazinyl)-6-(trifluoromethyl)pyrimidine

$C_{21}H_{29}F_3N_6O_2$  (454.5)

25

## Example 11

4-[4-(4-{[4-(Benzyloxy)-2-pyrimidinyl]oxy}butyl)-  
1-piperazinyl]-2-tert-butyl-6-(trifluoromethyl)-  
30 pyrimidine

m.p. 79-80°C (hydrochloride)

## Example 12

35

4-[4-(3-{[4-(Benzyloxy)-2-pyrimidinyl]oxy}propyl)-1-  
piperazinyl]-2-tert-butyl-6-propylpyrimidine

m.p. 146-148°C (fumarate)

- 20 -

## Example 13

2-{3-[4-(2-tert-Butyl-6-propyl-4-pyrimidinyl)-1-  
5 piperazinyl]propoxy}-4-pyrimidinol

m.p. 168-169°C (fumarate)

## Examples of pharmaceutical administration forms

10

## A) Tablets

Tablets of the following composition are pressed on a  
tablet press in the customary manner:

15

40 mg of the substance from Example 2

120 mg of maize starch

13.5 mg of gelatin

45 mg of lactose

20 2.25 mg of Aerosil® (chemically pure salicylic acid in  
submicroscopically fine dispersion)

6.75 mg of potato starch (as a 6% paste)

## B) Sugar-coated tablets

25

20 mg of the substance from Example 2

60 mg of core substance

70 mg of saccharification substance

30 The core substance consists of 9 parts of maize starch,  
3 parts of lactose and 1 part of vinylpyrrolidone-vinyl  
acetate copolymer 60:40. The saccharification substance  
consists of 5 parts of cane sugar, 2 parts of maize  
starch, 2 parts of calcium carbonate and 1 part of  
35 talc. The sugar-coated tablets which are prepared in  
this way are subsequently provided with a gastric  
juice-resistant coating.

Biological investigations - receptor binding studies

- 21 -

1) D<sub>3</sub>-binding test

Cloned human D<sub>3</sub> receptor-expressing CCL 1,3 mouse  
5 fibroblasts, obtainable from Res. Biochemicals  
Internat. One Strathmore Rd., Natick, MA 01760-2418  
USA, were employed for the binding studies.

## Cell preparation

10

The D<sub>3</sub>-expressing cells were multiplied in RPMI-1640  
containing 10% fetal calf serum (GIBCO No. 041-32400  
N); 100 U of penicillin/ml and 0.2% streptomycin (GIBCO  
BRL, Gaithersburg, MD, USA). After 48 h, the cells were  
15 washed with PBS and incubated for 5 min with PBS  
containing 0.05% trypsin. After that, the cell  
suspension was neutralized with medium and cells were  
collected by centrifuging at 300 g. For lysing the  
cells, the pellet was briefly washed with lysis buffer  
20 (5 mM Tris-HCl, pH 7.4, containing 10% glycerol) and,  
after that, incubated at 4°C for 30 min at a  
concentration of 10<sup>7</sup> cells/ml of lysis buffer. The  
cells were centrifuged at 200 g for 10 min and the  
pellet was stored in liquid nitrogen.

25

## Binding tests

For the D<sub>3</sub>-receptor-binding test, the membranes were  
suspended in incubation buffer (50 mM Tris-HCl, pH 7.4,  
30 containing 120 mM NaCl, 5 mM KCl, 2 mM CaCl<sub>2</sub>, 2 mM  
MgCl<sub>2</sub>, 10 mM quinolinol, 0.1% ascorbic acid and 0.1%  
BSA) at a concentration of approx. 10<sup>6</sup> cells/250 ml of  
test mixture and incubated with 0.1 nM <sup>125</sup>iodine  
sulpiride at 30°C in the presence and absence of test  
35 substance. Nonspecific binding was determined using  
10<sup>-6</sup>M spiperone.

After 60 min, the free radioligand and the bound  
radioligand were separated by filtration through GF/B

- 22 -

glass fibre filters (Whatman, England) on a Skatron cell collector (Skatron, Lier, Norway), and the filters were washed with ice-cold Tris-HCl buffer, pH 7.4. The radioactivity which had collected on the filters was  
5 quantified using a Packard 2200 CA liquid scintillation counter.

The  $K_1$  values were determined by means of nonlinear regression analysis using the LIGAND program.

10

## 2) D<sub>2</sub>-binding test

### Cell culture

15 HEK-293 cells possessing stably expressed human dopamine D<sub>2</sub>A receptors were cultured in RPMI 1640 containing Glutamax I<sup>TM</sup> and 25 mM HEPES containing 10% fetal calf serum. All the media contained 100 units of penicillin per ml and 100 µg of streptomycin/ml. The  
20 cells were kept at 37°C in a moist atmosphere containing 5% CO<sub>2</sub>.

The cells were prepared for binding studies by trypsinizing (0.05% trypsin solution) for 3-5 minutes  
25 at room temperature. After that, the cells were centrifuged at 250 g for 10 minutes and treated at 4°C for 30 minutes with lysis buffer (5 mM Tris-HCl, 10% glycerol, pH 7.4). After centrifuging at 250 g for 10 minutes, the residue was stored at -20°C until used.

30

### Receptor binding tests

"Low affinity state" dopamine D<sub>2</sub> receptor using <sup>125</sup>I-spiperone (81 TBq/mmol, DuPont de Nemours, Dreieich)

35

The assay mixtures (1 ml) consisted of  $1 \times 10^5$  cells in incubation buffer (50 mM Tris, 120 mM NaCl, 5 mM KCl, 2 mM MgCl<sub>2</sub> and 2 mM CaCl<sub>2</sub>, pH 7.4 with HCl) and 0.1 nM <sup>125</sup>I-spiperone (total binding) or, additionally, 1 µM

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haloperidol (nonspecific binding) or test substance.

After having been incubated for 60 minutes at 25°C, the assay mixtures were filtered through GF/B glass fibre  
5 filters (Whatman, England) on a Skatron cell collector (from Zinsser, Frankfurt), and the filters were washed with ice-cold 50 mM Tris-HCl buffer, pH 7.4. The radioactivity which had collected on the filters was quantified using a Packard 2200 CA liquid scintillation  
10 counter.

The experiment was analysed as above.

The  $K_i$  values were determined by nonlinear regression  
15 analysis using the LIGAND program or by converting the  $IC_{50}$  values using the Cheng and Prusoff Formula.

In these tests, the compounds according to the invention exhibit very good affinities at the  $D_3$   
20 receptor ( $< 1 \mu\text{molar}$ , in particular  $< 100 \text{ nmolar}$ ) and bind selectively to the  $D_3$  receptor.

#### Test for oral bioavailability

25 The test substances were administered to male Wistar rats in parallel experiments, in one case intravenously (tail vein, 2 mg/kg of body weight) and in the other case orally (by gavage, 10 mg/kg of body weight). For the intravenous administration, the test compound was  
30 dissolved in physiological sodium chloride solution containing 1 vol% dimethyl sulphoxide while, for the oral administration, it was dissolved in water containing 0.5% hydroxymethylpropyl cellulose. At different times (intravenously: 0.083; 0.25; 0.5; 2; 8  
35 and 24 h; orally: 0.5; 1; 3; 8 and 24 h) after the administration, two rats were anaesthetized with dinitrogen oxide and a blood sample was withdrawn. Centrifugation was used to obtain plasma samples in which the concentration of the test compound was

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determined using coupled liquid chromatography/mass spectroscopy. The area under the plasma concentration time curve (AUC) was calculated from the results which were obtained using the trapezium method

5 [(( $t_n - t_{n-1}$ ) × ( $c_n + c_{n-1}$ )/2), in which  $t_n$  is the time of the determination and  $t_{n-1}$  is the time of the preceding determination, and  $c_n$  and  $c_{n-1}$  are the plasma concentrations at times  $t_n$  and  $t_{n-1}$ , respectively]. The bioavailability was determined in accordance with the

10 Formula

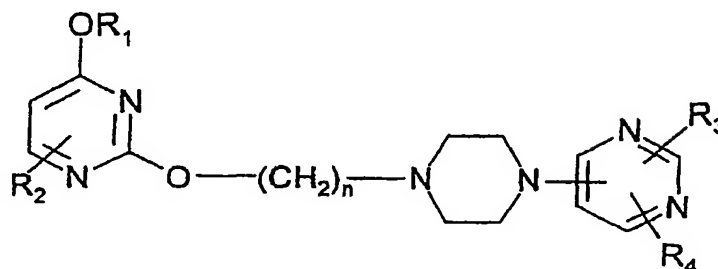
$$\frac{AUC_{\text{oral}} \times \text{dose}_{\text{intravenous}}}{AUC_{\text{intravenous}} \times \text{dose}_{\text{oral}}}$$

It was found that the compounds according to the invention exhibited a bioavailability which was

15 markedly higher than that of comparison compounds which did not correspond to the Formula I.

Patent Claims

## 1. Pyrimidinoxyalkylpiperazines of the Formula I:



5

in which:

n represents an integer from 2 to 6,

10

R<sub>1</sub> represents H, C<sub>1</sub>-C<sub>6</sub>-alkyl or phenyl-(C<sub>1</sub>-C<sub>6</sub>)-alkyl in which the phenyl radical can be substituted by one or more substituents selected from C<sub>1</sub>-C<sub>6</sub>-alkyl and C<sub>1</sub>-C<sub>6</sub>-alkoxy,

15

R<sub>2</sub> represents H, C<sub>1</sub>-C<sub>4</sub>-alkyl, OH, C<sub>1</sub>-C<sub>6</sub>-alkoxy, NH<sub>2</sub> or C<sub>1</sub>-C<sub>6</sub>-halogenoalkyl,

20

R<sub>3</sub> and R<sub>4</sub>, independently of each other, represent H, C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>1</sub>-C<sub>6</sub>-hydroxyalkyl, C<sub>1</sub>-C<sub>6</sub>-halogenoalkyl, pyrrolyl or phenyl, which latter can be substituted by one or more substituents selected from C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>1</sub>-C<sub>6</sub>-hydroxyalkyl, C<sub>1</sub>-C<sub>6</sub>-alkoxy, OH, halogen or C<sub>1</sub>-C<sub>6</sub>-halogenoalkyl, phenyl, cyano or nitro,

25

30

with the proviso that the radicals R<sub>3</sub> and R<sub>4</sub> on the pyrimidine ring are in each case arranged in the m position in relation to each other and to the piperazine substituent on the pyrimidine ring, and at least one of the radicals R<sub>3</sub> and R<sub>4</sub> represents C<sub>3</sub>-C<sub>6</sub>-alkyl or C<sub>3</sub>-C<sub>6</sub>-hydroxyalkyl, which in each case possesses a branched alkyl chain or is bonded

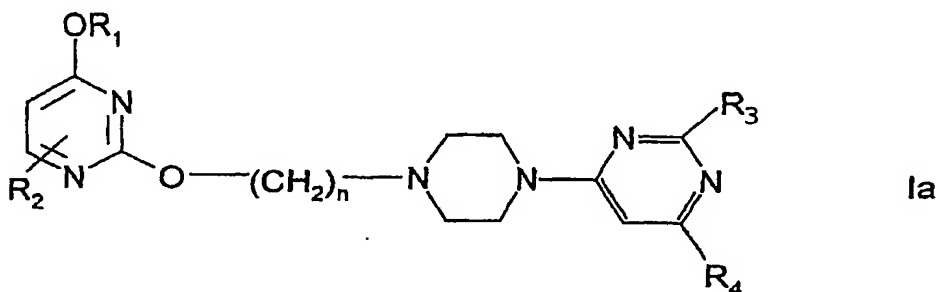
- 26 -

to the pyrimidine ring by way of a secondary carbon atom, or trifluoromethyl,

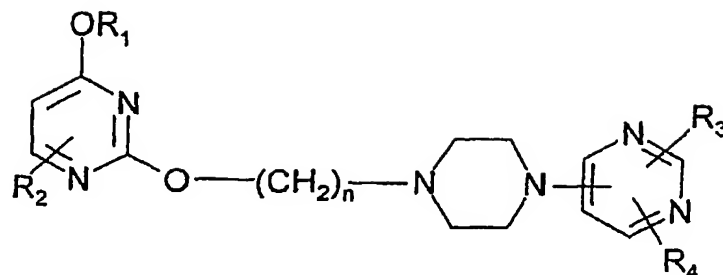
5 and their piperazine-N-oxides and salts with pharmaceutically tolerated acids.

2. Pyrimidinoxyalkylpiperazines of the Formula I according to Claim 1, in which at least one of the radicals  $R_3$  and  $R_4$  represents  $C_3$ - $C_6$ -alkyl or  $C_3$ - $C_6$ -hydroxyalkyl which in each case is bonded to the pyrimidine ring by way of a secondary or tertiary carbon atom.  
10
3. Pyrimidinoxyalkylpiperazines of the Formula I according to Claim 1 or 2, in which  $R_1$  represents H or benzyl whose phenyl radical can be substituted by one or more  $C_1$ - $C_6$ -alkoxy radicals.  
15
4. Pyrimidinoxyalkylpiperazines of the Formula I according to Claim 3, in which  $R_1$  represents H.  
20
5. Pyrimidinoxyalkylpiperazines of the Formula I according to one of the preceding claims, in which  $R_2$  represents H, methyl, ethyl, OH,  $C_1$ - $C_6$ -alkoxy, trifluoromethyl or difluoromethyl.  
25
6. Pyrimidinoxyalkylpiperazines of the Formula I according to Claim 5, in which  $R_2$  represents H or OH.  
30
7. Pyrimidinoxyalkylpiperazines of the Formula I according to one of the preceding claims, in which  $R_3$  and  $R_4$ , independently of each other, represent H,  $C_1$ - $C_6$ -alkyl,  $C_1$ - $C_6$ -hydroxyalkyl,  $C_1$ - $C_6$ -halogeno-alkyl or phenyl, which latter can be substituted by one or more substituents selected from  $C_1$ - $C_6$ -alkyl,  $C_1$ - $C_6$ -alkoxy, halogen or phenyl.  
35

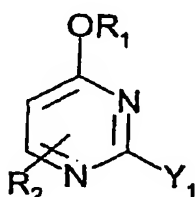
8. Pyrimidinoxyalkylpiperazines of the Formula I according to one of the preceding claims, in which n represents 3 or 4.
- 5 9. Pyrimidinoxyalkylpiperazines according to Claim 1 of the Formula Ia



- 10 in which R<sub>1</sub>, R<sub>2</sub>, R<sub>3</sub>, R<sub>4</sub> and n have the meaning given in Claim 1.
10. Pyrimidinoxyalkylpiperazines of the Formula Ia according to Claim 9, in which R<sub>3</sub> represents C<sub>3</sub>-C<sub>6</sub>-alkyl which is bonded to the pyrimidine ring by way of a tertiary carbon atom, and
- 15
- R<sub>4</sub> represents C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>1</sub>-C<sub>6</sub>-halogenoalkyl or phenyl, which latter can be substituted by one or more substituents selected from C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>1</sub>-C<sub>6</sub>-alkoxy, halogen or phenyl.
- 20
11. Pyrimidinoxyalkylpiperazines of the Formula Ia according to Claim 9, in which R<sub>3</sub> represents trifluoromethyl, and R<sub>4</sub> represents C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>1</sub>-C<sub>6</sub>-halogenoalkyl or phenyl.
- 25
12. Process for preparing a pyrimidinoxyalkylpiperazine of the Formula I

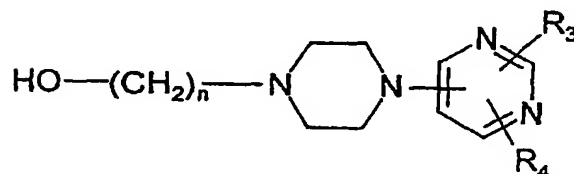


in which a compound of the Formula II



5

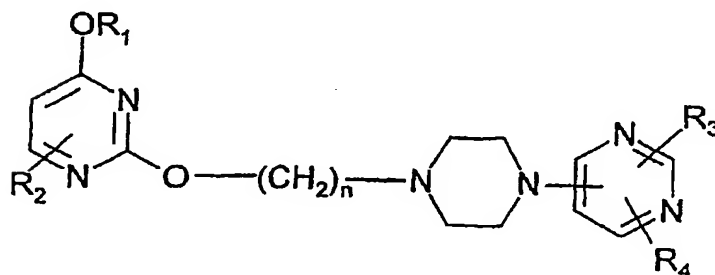
is reacted with a compound of the Formula III



10

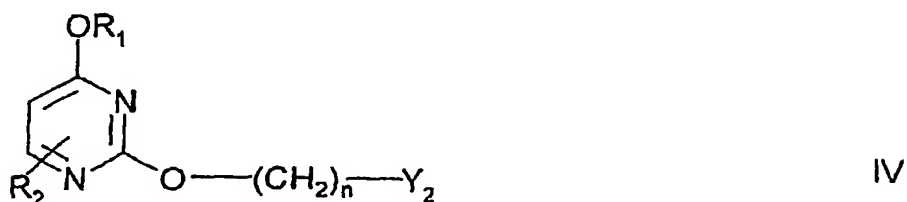
in which Y<sub>1</sub> represents a leaving group which can be displaced nucleophilically and R<sub>1</sub>, R<sub>2</sub>, R<sub>3</sub>, R<sub>4</sub> and n have the meaning given in Claim 1.

15 13. Process for preparing a pyrimidinoxyalkylpiperazine of the Formula I

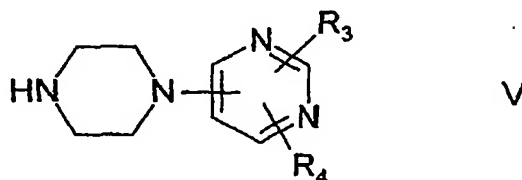


- 29 -

in which a compound of the Formula IV



5 is reacted with a compound of the Formula V



10 in which Y<sub>2</sub> represents a leaving group which can be displaced nucleophilically and R<sub>1</sub>, R<sub>2</sub>, R<sub>3</sub>, R<sub>4</sub> and n have the meaning given in Claim 1.

14. Pharmaceutical composition, which comprises at least one compound according to one of Claims 1 to 11, where appropriate together with physiologically acceptable excipients and/or adjuvants.

15. Use of at least one compound according to one of Claims 1 to 11 for producing a pharmaceutical composition for treating diseases which respond to modulation of the dopamine D<sub>3</sub> receptor.

## INTERNATIONAL SEARCH REPORT

International Application No

PCT/EP 02/07183

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 C07D239/34 A61K31/505 A61P25/18 A61P25/24 A61P25/30

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 C07D A61K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the International search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ, CHEM ABS Data

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2000 067847 A (BASF A.-G., GERMANY) 16 November 2000 (2000-11-16) page 1, line 7 - line 10; examples 10,11,19 page 3, line 1 -page 6, line 21 page 11, line 28 -page 12, line 7 ---	1-11,14, 15
Y	WO 97 25324 A (BASF AG ;UNGER LILIANE (DE); WICKE KARSTEN (DE); BLANK STEFAN (DE)) 17 July 1997 (1997-07-17) cited in the application page 5, line 11 - line 19; claims 1,15,16; examples 34,1-3,31,21,488,492,500,505,512,528,535,5 42,546 examples 549,561,559,564,569,570 --- -/--	1-15



Further documents are listed in the continuation of box C.



Patent family members are listed in annex.

## \* Special categories of cited documents:

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- \*O\* document referring to an oral disclosure, use, exhibition or other means
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\*X\* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

\*Y\* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

\*Z\* document member of the same patent family

Date of the actual completion of the international search

19 September 2002

Date of mailing of the international search report

09/10/2002

Name and mailing address of the ISA

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Hanisch, I

## INTERNATIONAL SEARCH REPORT

International #      tion No

PCT/EP 02/07183

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 96 02519 A (BASF AG ;HELLENDahl BEATE (DE); LANSKY ANNEGRET (DE); MUNSCHAUER R) 1 February 1996 (1996-02-01) cited in the application page 5, line 1 - line 12; claims 1,13,15,16; example 48; table 7 -----	1-15

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/EP 02/07183

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